OPERATING MANUAL

for the

DM2 LCD

and

DM2 LCDM

ULTRASONIC THICKNESS GAGES

CONTROLLED DOCUMENT

BRN

Procedure #:

Part # : (DM2LCD) **Code : OPP**

Model # : DM2LCD

Rev : **Print date :**

WARNING: Internal Document !

Check in the library at the end of each shift

Krautkramer Branson

Lewistown, Pennsylvania

IMPORTANT NOTICE

READ THE FOLLOWING INFORMATION PRIOR TO USING ANY KRAUTKRAMER BRANSON INSTRUMENTS. A FAILURE TO READ AND UNDERSTAND THE FOLLOWING INFORMATION WILL CAUSE ERRORS TO OCCUR DURING USE OF THE INSTRUMENT. SUCH ERRORS MAY, IN TURN, LEAD TO PROPERTY DAMAGE OR PERSONAL INJURY.

GENERAL WARNING

Proper use of ultrasonic test equipment requires three essential elements:

- Selection of the correct testing equipment.
- Knowledge of the specific "Test application requirements."
- Training on the part of the instrument operator.

This operating manual provides instruction in the basic set-up and operation of the test equipment. There are, however, additional elements which affect the proper use of ultrasonic test equipment. Specific information regarding these additional elements is beyond the scope of this manual. The operator should refer to textbooks on the subject of ultrasonic testing for more detailed information.

OPERATOR TRAINING

Operators must receive adequate training before using ultrasonic test equipment. Operators must be trained in general ultrasonic testing procedures and in the set-up and performance required by a particular test. Operators must understand:

- Soundwave propagation theory.
- Effects of the velocity of sound of the test material.
- Behavior of the soundwave where two different materials are in contact.
- Areas covered by the sound beam.

If the operator lacks this basic knowledge, the operator may receive and rely upon incorrect data. Property damage or personal injury may result.

More specific information about operator training, qualification, and certification is available in ASNT-TC1A and in many other industry specifications.

TEST APPLICATION REQUIREMENTS

Every ultrasonic test has certain test application requirements. These include:

- Determination of what is to be tested.
- Selection of a suitable test technique.
- Evaluation of test material conditions.
- Selection of acceptance/rejection limits.

Operators must be informed of the test application requirements before testing by those responsible for the product. Previous experience with the test material is the best basis for determining test application requirements. Additional information concerning test specifications and procedures is available from various Technical Societies, Industry Groups, and Government Agencies.

TESTING LIMITATIONS

In ultrasonic testing, information is obtained only from within the limits of the sound beam. Operators must exercise great caution in making inferences about the test material outside the limits of the sound beam. For example, when testing large material it may be impossible or impractical for the operator to perform a complete, one hundred percent inspection. When less than a complete inspection is to be performed, the operator must be shown the specific areas to inspect. When data from these areas are evaluated, qualified quality assurance personnel may use statistical and probability techniques to make inferences about areas not inspected.

Sound beams reflect from the first interior surface encountered. Because of part geometry and overlapped flaws or overlapped surfaces, reflections from hidden flaws or surfaces may go undetected. Operators must take steps to assure that the entire thickness of the test material is being examined.

The operator is directed to section _____ in this manual for additional information concerning the evaluation of flaw echoes.

ULTRASONIC THICKNESS MEASUREMENTS

Ultrasonic thickness measurement is the mathematical result of multiplying the velocity of sound in a material by the transit time of the soundwaves traveling through the material. Prior to use, the instrument is calibrated to the material's sound velocity. The instrument measures the transit time and displays a thickness value by multiplying the sound velocity and transit time.

Velocity of Sound

Accurate ultrasonic thickness measurement and flaw location depend upon the velocity of sound in the material. The velocity of sound varies because of characteristics of the test material. Velocity is not affected by the test instrument. Before testing begins, the operator must calibrate the instrument to the velocity of sound of the test material. The manual describes how to calibrate the instrument when the velocity of sound is known. If the velocity of sound is not known, the instrument can still be calibrated if a sample of the test material with known thickness is available.

Ultrasonic instruments work by assuming that the velocity of sound is uniform in the test material. Sometimes, however, the test material's velocity of sound is not uniform. The instrument should, therefore, be recalibrated from time to time to check that the velocity of sound of different tested parts is the same. If the instrument is not recalibrated, the operator may receive erroneous measurements which could result in property damage or personal injury.

Temperature Dependence

Velocity of sound of the test material is affected by the material's temperature. When testing a material subject to different temperatures, the operator should frequently recalibrate the instrument using a sample at the test temperature.

Temperature differences can also affect the probe delay line and the instrument itself. Frequent recalibration of the test instrument at the test temperature will reduce errors caused by temperature variations.

Testing Corrosive Areas

Ultrasonic testing of materials subject to corrosion, erosion, and pitting requires special attention. Operators should consider both previous experience and calculations for determining highly corrosive areas so as to achieve error-free measurements.

WARRANTY

When used in accordance with the manufacturer's written instructions and under normal operating conditions, KRAUTKRAMER BRANSON, (KB) test instruments are guaranteed to be free from defects in material and workmanship, for a period of one (1) year from date of shipment. KB will repair free of labor and material charges, any unit which proves defective within 90 days from date of original shipment by KB or by an authorized representative or distributor, and during the remainder of the one-year period KB will replace or repair defective parts or defective workmanship, customer to pay labor charges only.

All repair work will be made F.O.B. Lewistown, Pennsylvania, or at an authorized repair station as advised by KB, provided the defective unit is returned properly packed with all transportation charges prepaid. Any and all equipment replacement will be at the sole discretion of KB.

This warranty shall not apply to equipment subjected to misuse or abuse, improper installation, alteration, neglect or accident. Excluded from this warranty coverage are expendable items such as transducers, interconnecting cables, batteries, and vacuum tubes when used in the instrument. Accessory items such as recorders, etc. will be covered under the original manufacturer's warranty as given to KB.

This warranty is limited to the original purchaser and is not transferable. No other warranty, either expressed or implied is made.

SERVICE

Should service become necessary, KB has established a number of authorized Service Centers throughout the United States and Canada. For the location of the nearest facility, contact:

Manager, Repair Department
Krautkramer Branson
P.O. Box 350
Mifflin County Industrial Park
Lewistown, Pennsylvania 17044
Telephone: (717) 242-0327 or 242-0331

Comments or questions concerning this manual should be directed to:

Thickness Gauge Product Manager
Krautkramer Branson
P.O. Box 350
Lewistown, Pennsylvania 17044
Telephone: (717) 242-0327 or 242-0331

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I. Introduction

1-1 The Krautkramer-Branson DM2 LCD and LCDM are portable, pocket-sized ultrasonic thickness measuring instruments. They are designed for simplicity of operation and can be used after a few simple instructions. The DM2 LCD and LCDM are especially intended for measurement of remaining wall thickness of pipe, pressure vessels, and other components subjected to corrosion, erosion and certain cases of pitting. Of course, determination of the effects of corrosion, erosion or pitting on the safety of a pipe or pressure vessel can only be made by a person knowledgeable in the field.

1-2 Technical Data and Specifications.

Indication: 4 digit LCD readout.

Instrument Measuring Range: To 9.999 in. (DM2 LCD) 999.9mm (DM2 LCDM). Actual ranges will depend upon transducer and test material.

Display Resolution: ±.001 in. (DM2 LCD) over the entire measuring range; ±.1mm for the metric version (DM2 LCDM).

Test Material: Virtually all materials with acoustic velocities ranging from 1 to 999 in./sec. x 10^3 (1-999 cm/sec x 10^3).

Allowable surface temperature of the test specimen: Dependent on probe used; see probe data sheet.

Ambient temperature range (instrument): +14°F to +122°F (−10°C to +50°C). LCD display may show approximately a 30% slowdown in update rate at 0°C. At −10°C, slowdown approaches 100%.

Coupling Check: The colon between the second and third digit in the readout disappears when coupling has occured.

Battery Check: The decimal point in the readout blinks to indicate low battery condition.

Discharge Protection: Automatic switch-off after an approximately 4-minute interruption in measuring.

Voltage Supply: 5 rechargeable NiCad cells (standard) or five 1.5V, size AA dry cells (not rechargeable).

Charging NiCad Batteries: By means of charger 110V, 60 Hz.

Power Consumption: < 0.35 Watts

Operating Time: At least 8 hours with continuous indication; at least 12 hours with normal measuring operation.

Dimensions: 2-3/4 in. x 6 in. x 1-1/2 in. (WxHxD).
65mm x 150mm x 33mm

Weight: approx. 14 oz. (400 grams) including batteries.

HOW ULTRASONIC THICKNESS MEASUREMENT WORKS

1-3 Ultrasonic Thickness Gages work on the same principle as sonar. A burst of ultrasound is transmitted by a probe (transducer) into the test material. The sound travels through the test material until it reaches a material of substantially different physical character from the test material. The sound is then reflected back to the probe. The precise measurement of the time needed for the ultrasound pulse to make the round trip in the material is used by the DM2 to determine the thickness of the test material.

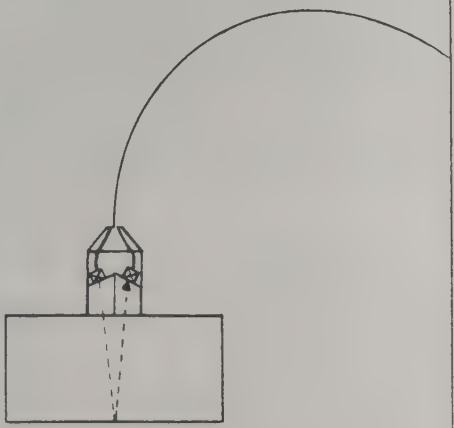

Figure 1-1 Ultrasonic Thickness Measurement

How the DM2 Measures Thickness

1-4 The DM2 measures ultrasound travel time in units small enough to provide a display resolution of ±.001 in. (±.1mm for the metric version).

To achieve these readings, the instrument employs a "Scaled Averaging" technique. The mechanical resonance of a quartz crystal generates a timing (or "counting") frequency more stable than that of a tuning fork. Since this frequency is high, the time being measured can be divided into exceedingly fine increments. The crystal in the DM2 is used as a "Digital Clock" to measure the time it takes for the ultrasound pulse to make a round trip through the test material. Multiplying the elapsed time by the test material's acoustic velocity gives the total round trip distance traveled by the sound beam. Half of this distance is, of course, the precise thickness of the material. Circuitry for summing and averaging within the DM2 performs the signal processing.

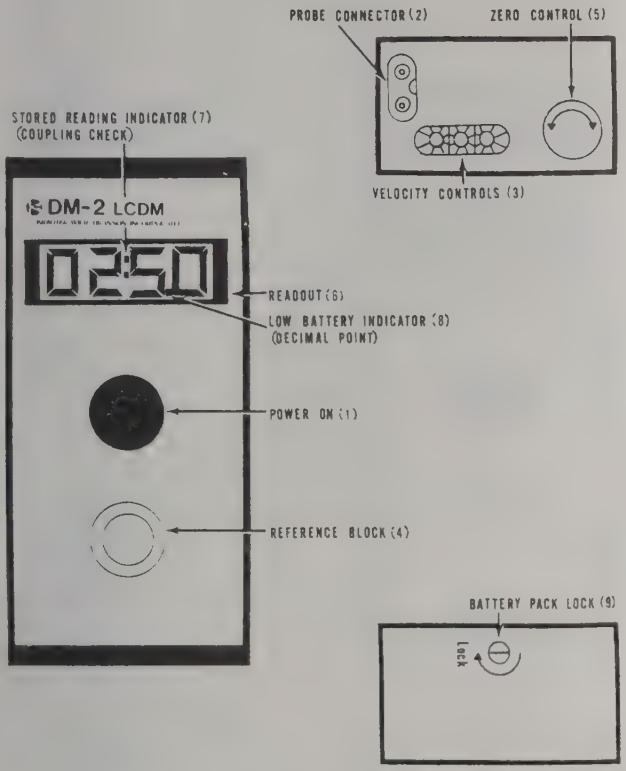

Figure 2-1a Operation Controls — DM-2 LCDM

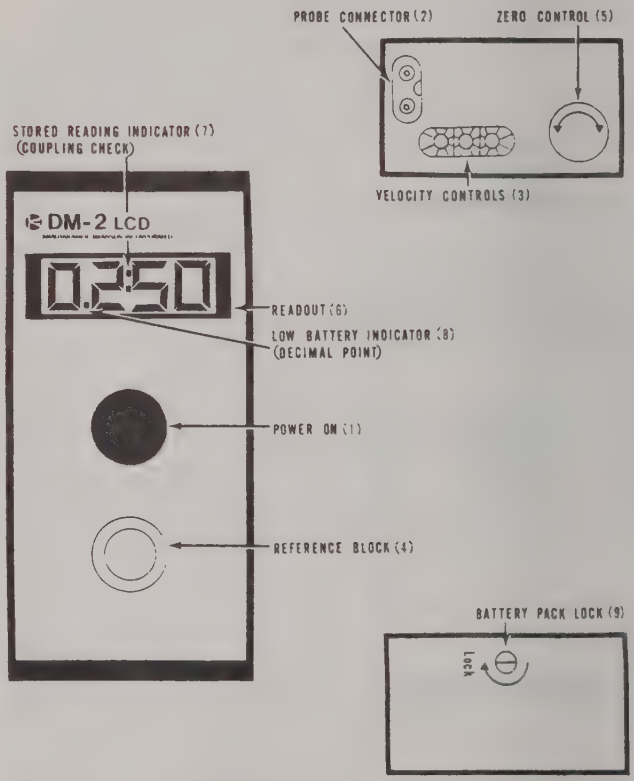

Figure 2-1b Operation Controls — DM-2 LCD

TABLE 2-1

Longitudinal Velocity
Nominal Longitudinal Velocity

	In/Sec x 10^3	Cm/Sec x 10^3
Air	013	033
Aluminum	249	632
Brass	150	380
Cadmium	109	278
Cast Iron	181	460
Copper	185	470
Silver	141	360
Gold	128	324
Stellite	278	705
Iron	232	590
Steel, Mild	232	590
Lead	085	216
Magnesium	227	577
Manganese	183	466
Mercury	057	145
Nickel	221	563
Platinum	130	330
Tin	131	332
Tungsten	215	546
Zinc	164	417
Aluminum Oxide	343	870
Epoxy Resin	104	265
Glass, Flint	168	426
Glass, Crown	223	566
Ice	156	398
Paraffin Wax	087	220
Acrylic Resin (Perspex)	107	273
Polyamide (Nylon, Perlon)	094	238
Polystyrene	093	235
Porcelain	232	590
Quartz Glass (Silica)	219	557
Rubber, Soft	058	148
Rubber, Vulcanized	091	230
Teflon	053	135
Glycerine	076	192
Methylene Oxide	393	998
Diesel Oil	049	125
Oil (SAE 30)	069	174
Water (20°C)	058	148

II. Operation

2-1 Basic Operation (See Figure 2-1)

Depress "POWER ON" button (1) in the center of the face of the instrument. The LCD display will immediately go on and will display all zeroes. (The colon which indicates a stored reading will also go on.)

2-2 Plug the large Lemo connector end of the transducer cable into the instrument, and attach the small Microdot connectors to the probe.

NOTE: The Lemo connector has a small tab on one side to assist in proper orientation of the connector with the instrument.

2-3-1 Set the appropriate acoustic velocity for the material being tested (see Table 2-1) on the velocity controls (3). Then measure a known sample thickness of the material and, using the zero control (5), adjust the DM2 to display this known thickness.

2-3-2 When testing mild steel with the inch version of the DM2 for example, set the velocity controls to the acoustic velocity in English units (232 in./sec. x 10^3); the readout will then display measurements in inches.

When testing mild steel with the metric DM2, set the velocity switches to the acoustic velocity in metric units (590 cm/sec x 10^3). The readout will then display measurements in millimeters. See Table 2-1 for typical acoustic velocities of various materials.

Couple the probe to the built-in "Reference Block" (4) and, using the "Zero Control" (5), set the digital "Readout" (6) to the thickness marked on the reference block (4).

Before actual testing, a final check of the calibration can be made by measuring a sample of the material to be tested whose thickness is known. This sample should be within the anticipated range of thicknesses to be tested. If the thickness reading displayed is different from the actual thickness of this sample, the probable reason is that the actual velocity of sound in the sample test material is slightly different from

the velocity setting on the DM2's velocity controls. If this deviation is outside the test tolerance of the particular test to be conducted, a more accurate velocity setting should be determined. To do this, obtain two samples of the actual test material. These samples should be of different, known thicknesses, within the anticipated range of thicknesses to be tested. Using these two samples, follow the calibration procedure outlined in Para. 2-3-3.

NOTE: The instrument should be calibrated under actual test conditions, using a sample of the material to be tested, whenever possible. Changes in temperature may cause faulty readings if the calibration is done at one temperature, and testing is done at another temperature.

2-3-3 Finding Sound Velocity

If the sound velocity of the test material is unknown the DM2 can be used to determine this value. Two samples of different thicknesses of the material to be tested are needed. The exact thicknesses of these two samples must be known. To find the sound velocity of the unknown material, perform the following procedure:

(a) Couple the probe to the thicker of the two samples and adjust the velocity control (3) until the readout (6) displays the correct thickness of this sample.

(b) Couple the probe to the thinner of the two samples and adjust the zero control (5) until the readout (6) displays the correct value.

(c) Repeat steps (a) and (b) until the readout (6) displays the correct values for both samples without requiring further control adjustments. The velocity control now indicates a figure which is approximately the acoustic velocity of the material being tested. The unknown material's velocity should be noted for future testing of the same material under the same conditions.

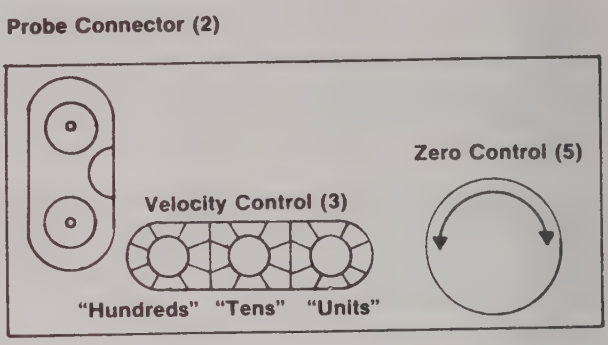

Figure 2-2 Velocity Controls

NOTE: To set the velocity control (3) for an unknown material, adjust the screwdriver adjustment nearest the probe connector (2) first. For the sake of convenience, this will be referred to as the "hundreds" adjustment. (All values correspond to the velocity of ultrasound in inches or Cm/Sec x 1000.) This will give the coarse velocity. Next, set the center adjustment (tens). Then set the adjustment nearest the zero control (5) (units).

NOTE: The positions "A", "C" and "E" on the velocity controls are not operative.

2-4 Testing

Remove any loose surface scale or flaking from the test surfaces.

2-5 Spread a thin layer of couplant on the test surface and place the probe gently, but firmly on the couplant surface.

2-6 Many materials may be used as couplant, but HiTempco, ZGT and Exosen couplant are recommended. Light oil (#10) also makes a good couplant.

NOTES: Couplant must always be used when testing. When testing hot surfaces, use a couplant designed for high temperature testing, such as ZGM.

2-7 The colon serves as a coupling check indicator. When the colon disappears, the instrument is coupled to the test piece and is taking readings. When the colon is displayed, the instrument shows a stored reading which means that the unit is **not** coupled to the test piece.

NOTE: When testing, pay close attention to the colon display, to ensure that a **new** reading is made for each new spot being measured.

2-8 Read the thickness of the test material in the readout (6) display.

2-9 Additional Considerations

When measuring on curved surfaces, (e.g., pipe or tubing) be sure to position the probe so that the cross-talk (acoustic isolation) barrier of the probe is across the length of the tube (at right angles to the longitudinal axis).

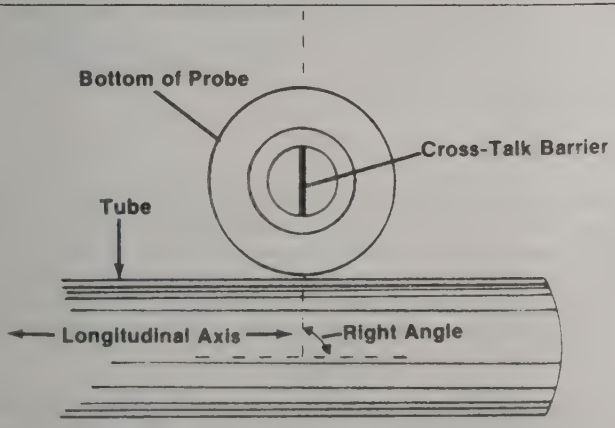

Figure 2-3 Probe Alignment, Curved Surfaces

2-10 If, during the testing, the DM2 suddenly reads a value which does not seem to be correct (for example, a value much thinner than the apparent thickness of the test piece), the instrument may be reading to a flaw or lamination in the test piece rather than to the backwall (see "How Ultrasonic Thickness Measurement Works", page 3). Such indications should be checked with an ultrasonic flaw detector.

2-11 A regular pattern on the surface of the test piece, such as machine grooves, can cause a false indication (low thickness value). This condition can be corrected, in most cases, by rotating the transducer to align the cross-talk barrier at right angles to the grooves.

2-12 In spite of the high sensitivity and penetration characteristics of the DM2, it is possible that a test specimen may have a surface which is too rough to permit a good test. On a specimen with a particularly rough surface it is possible to get extremely low readings, unstable readings, or no reading at all. This problem can usually be corrected by grinding the surface until it is smooth enough to permit proper testing.

2-13 An effect known as doubling can occur when the instrument is used on materials below the minimum thickness range of the probe being used. This results in an indication of a value twice the actual thickness of the test specimen. It is therefore advisable to double-check critical readings with an ultrasonic flaw detector. (See probe data sheet for information on specific probes.)

2-14 Batteries

The instrument has an automatic switch-off device which switches the instrument off completely if a measurement has not been taken for approximately 4 minutes. Do not attempt to shut the instrument off by depressing the "Power On" button (1); this only extends the instrument's "on" time. The DM2 will automatically shut itself off approximately 4 minutes after the last reading.

2-15 With fully charged NiCad batteries, the DM2 LCD and LCDM each have a total of at least 12 hours operating time (when measuring with normal measuring intervals).

2-16 Low battery charge level is indicated by means of an LCD decimal point (8)in the readout. If the decimal point blinks, a minimum remaining operating time of 15 minutes can be expected before the batteries must be changed. When the readout (6) does not light at all, the batteries are dead. When using dry cells, the blinking diode indicates approximately "half time" remaining.

2-17 To change the batteries, unlock the battery pack by rotating the battery pack lock (9) counterclockwise. Remove the battery pack from the DM2 housing, and connect it to a 110V, 60 Hz battery charger. If the charger has been set on "normal charge", batteries which have been discharged in the normal manner (blinking decimal point indication) will be fully recharged after 14 hours.

2-18 To replace the batteries, simply insert the battery pack into the DM2 housing and rotate the battery pack lock (9) clockwise until it is firmly tightened. If a battery pack has been incorrectly inserted, the "ON" switch will be blocked so that neither the electronics nor the batteries can be damaged.

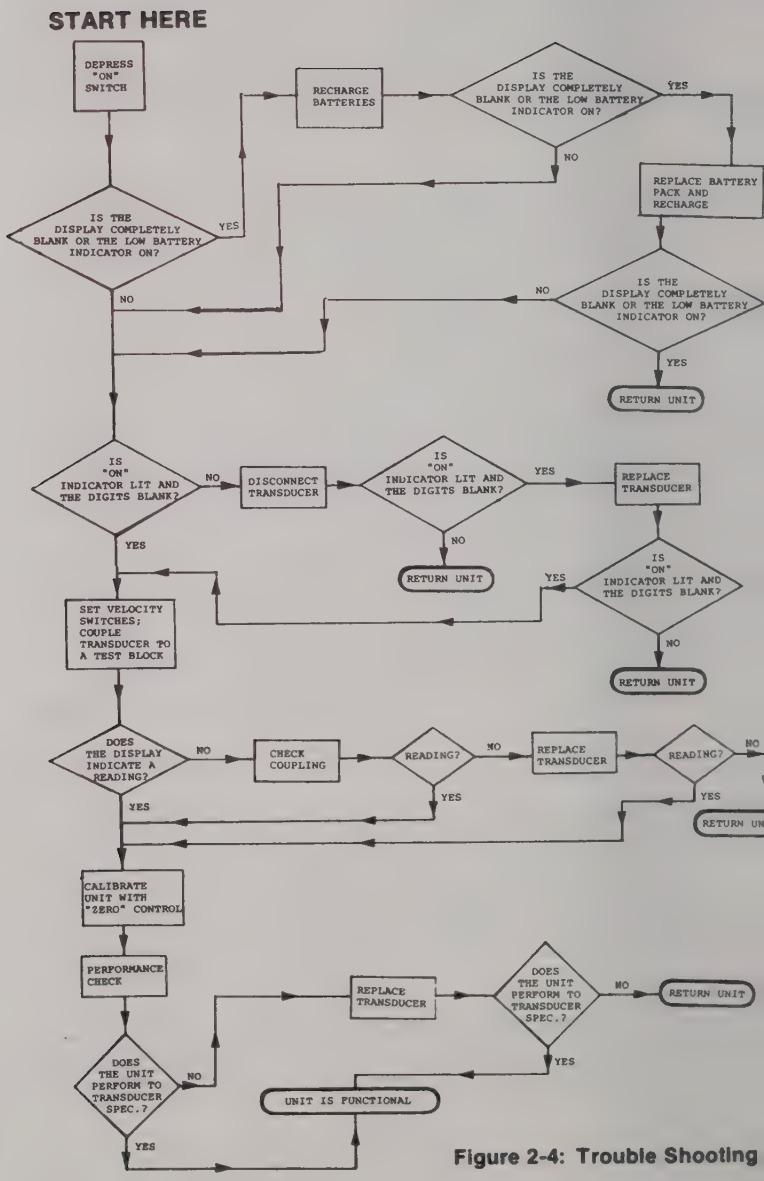

Figure 2-4: Trouble Shooting

MP MASTER
MA33923